CLAY SOILS AND CONCRETE.

Sir,—The observations in No. 142 of The Builder, by Henry Liddell, on the dangers accruing to buildings erected on clay soils, without due precautions being given to the foundations, and the instances which he brings forward of the fatal results exemplified in the buildings about Hull, are of serious importance, and merit the consideration of all practical persons. I will venture to make a few additional remarks.

In all foundations, but especially in uncertain soils, a great degree of security is obtained by making the footings and lower part of the walls of increased thickness. The foundations, from the better bond thus obtained, are less liable to fracture and are more capable of bearing heavy weights by the greater spread of surface over which they are diffused. In illustration of the security thus obtained, the use of snow boots in Canada has been referred to, which extend, almost like sledges, under the feet, and thus effectually prevent the impression which the small extent of the bearing surface of a foot would inevitably make. By the diffusion of the weight scarcely any compression takes place, and the same result may be obtained by similar means in soft or clayey soils, by extending the width of the footings.

In clay soils, another point to be attended to, is that the foundations be of sufficient *depth*, to prevent the soil on which they are constructed being affected by the changes of the weather, from wet to dry, or otherwise. The cracking of these soils by the heat of summer, and their swampiness in winter is well known. If it is necessary for an architect to take into consideration the effect of the dilatation of iron by heat, how much more should he consider the effect which such changes have upon a soil, the very foundation of his building. In clay lands, I think the bottom of the footings should never be less than five feet below the surface, to avoid the effects of temperature. The drainage for buildings also on these soils should not be made *below* the level of the foundations, as great injury is likely to arise from withdrawing the natural moisture of the ground beneath them. I have known serious injury to arise, and a building to be fractured in all directions, from the sinking of a well in a clay soil, whereby the under soil was drained of its moisture.

Your correspondent alludes to concrete, and doubtless it is a most efficient means for securing good foundations, but I apprehend its beneficial effect arises, in a great measure, from its enabling the builder to effect the two conditions above named, at a moderate expense; viz. of extending the width of the footings and increasing the depth of the underground work;—for it must be remembered that the concrete itself is only an artificial wall, and subject therefore to all the contingencies which may affect the soil on which it rests. In addition to concrete on clay soils, I have adopted the plan (and with much success) of building all the footings four or six courses in height of brickwork in cement, each course strongly bonded with iron hooping, laid both longitudinally and diagonally. Iron hooping has been looked upon so much as a mere substitute for wood bond, that its advantages of being a connecting tie to the individual bricks, and the increased mutual strength which they thereby obtain, are not sufficiently appreciated. I make this observation, as the use of iron hooping in footings has been objected to as unnecessary and useless by several practical builders; but I hold that the footings thus constructed of sound stocks and cement, linked together by iron hooping, form a stronger and more compact bearing surface than could be obtained by Yorkshire landings. The connecting bond is in no part broken throughout the footings, as must be the case with landings.

I should have supposed the use of concrete was too well known to need your correspondent's inquiry, had I not myself found a difficulty sometimes of getting it executed in the country. In London, the ballast from the river bed is invariably used, but in the country, any clean pit gravel, fragments of stone and brick, the shingle from the sea-shore, and broken flints, may all be advantageously used, mixed with coarse, rough sand sufficient to fill up the interstices. Six parts of this material with one of ground lime is recommended; or, if the lime is strong and hydraulic, a smaller portion of it may be used. As it is difficult in the country to obtain ground lime readily, a labourer can be set to pound it into powder. To slake it with the other material is wasteful. I subjoin a translation from one of the chapters in Philibert de L'Ome's work, published in 1568, giving an account of the use of concrete in his time, which I have not seen noticed in any publication on the subject.

2nd Book, Chapter 2:—"How foundations are to be made, when large stones cannot be obtained, for building bridges across rivers, harbours on the sea-coast, and other works in marshes and in water.

"The excavations being made, whether for houses, harbours, bridges, or buildings, in a marshy soil, or even on land, and if being deep and wide, stones of a large size cannot be obtained for the foundations, the best and surest method is to prepare a *mortar*, composed of quick-lime recently burnt, as described in the first book, mixed with a river sand, which contains a quantity of pebbles of all sizes, provided the largest be not larger than the fist, or the size of an egg, and that the whole be also interspersed with smaller pebbles and gravel, such as are usually found in rivers. This material, moistened with water and mingled with lime, serves both for mortar and stone, and mixed with a sufficient quantity of sand, must be thrown at once into the excavation without any labour from the mason's trowel. It is only necessary to dress it with the spade. Having thrown in a layer, about half a foot in thickness, large single stones may also be thrown in, and mixed here and there with it as may be convenient, but without touching each other; after this, you will again throw upon them the mortar of pebbles and gravel as before done, and this must be repeated till the excavation is full, throwing the whole from above with all sorts of small pebbles. This composition thus executed hardens and solidifies so firmly in the foundation, that being heaped up in a mass, and bound together, it becomes a uniform body or rock, such as Nature forms, of a single block, and it is so strong and hard, that when dry, it cannot be broken either by piles or any other instrument, nor can the pebbles be separated from it without breaking them in pieces. The reason is, that the excavations, retaining their humidity dissolve the mortar and prevent its drying for some time, so that the large gravel and pebbles during this period imbibe and draw in the fatness and power of the lime even to their very centre, as I have myself observed; for on examining the pebbles thus employed, and breaking them, I have found them white to their very centre, and of the same colour as the lime. Quarry stones can do the same, for they attract the fatness and power of the lime. A foundation of small size cannot be executed in this manner, as the stones or pebbles would dry too rapidly, and before they had time to absorb the virtue of the lime. Lime made from hard stone or marble is the most penetrating and proper for this purpose, but observe especially that soft free-stone lime is useless."

It is needless to continue the extract, and your readers will probably not understand the old architect's philosophy; but the chapter is interesting as evidencing the use of a material three centuries ago, which we are inclined to consider a modern discovery. I am, Sir, &c.

October, 1845. T. L.

*** In the prize essay on concrete, published in the first part of "Transactions of Institute of British Architects," 1836, numerous instances of the use of concrete in very early times are cited. In reply to our first correspondent, Mr. Liddell, we give the following brief extracts from the essay in question.

"The concrete now generally employed is compounded of Thames ballast and Dorking lime, in certain proportions, varying, according to the opinion of the user and goodness of the materials, from one of lime and four of ballast, to one of lime and twelve of ballast. They are sometimes mixed together, slaked as mortar, and thrown into the foundation from a certain height; sometimes the ballast is laid on the site of the intended erection, and the lime poured over it, in the shape of grout; while at other times the spaces to be concreted are filled with water, and the lime and ballast, having been first mixed in proper proportions, are thrown into it dry. Instead of gravel, Kentish-rubble and broken pieces of granite, properly grouted, have been extensively employed, more especially by Sir John Soane, who has used a preparation of this sort for most of the public buildings in Westminster executed under his direction; viz., at the Law Courts, the additional buildings to the House of Lords, the library of the House of Commons, the Board of Trade and Privy Council Offices, the State-Paper Office, and others. The foundations of these edifices were formed of granite, or other hard stone, broken in small pieces (none exceeding the size of an ordinary hen's egg) and laid in layers, closely rammed, and grouted every third layer with a grout composed of Dorking lime and sharp river-sand; other layers of similar pieces of stone were then laid, and rammed and grouted as before; and so the operation was repeated, until the required thickness was attained."

"In order properly to apportion the quantity of lime necessary to be used with the ballast, it will be well that you ask yourself this question: What are you in reality doing when forming a mass of concrete? or rather, what *ought* to be done? To this the answer must be, that you are building a stone wall.

The pebbles, then, are *the materials with which it is to be built*, and must be regarded only in that light; so that in considering the quantity of lime necessary to be added, in order to form a *proper mortar* wherewith to unite them, regard must alone be had to the sand contained in the ballast, and according to the quantity and quality of that ingredient must be apportioned the lime. It is true, that upon the proportion borne by the pebbles to the mortar, the strength and goodness of the concrete materially depend; but this, except under peculiar circumstances, must but little interfere with the preparation of the mortar: it is another question separately to be considered.

Now, practice and a variety of experiments have shewn that Dorking stone lime, being ordinarily good, will form a most excellent mortar when mixed with three times its own quantity, by measure, of sand; and although it is quite certain that if it be well burned, ground, and used hot—and thus it *must always* be for concrete—it will make excellent mortar when mixed with four of sand,* even better if the lime be powerful than with less, this may serve us as a generally admitted good proportion.†

With respect to the amount of stones essential to a good concrete, it is generally maintained by those practical men who have thought upon the subject—unfortunately but few—that it should be double that of the sand by measure; and my own experience fully bears out this belief."

Various experiments shewed that *two parts of stones and one of sand, with sufficient lime—dependant on the quality of the materials—to make good mortar with the latter, formed the best concrete.*

Thames ballast, of the best sort, consists, nearly, of one of sand and two of stones; in ordinary practice, one of lime to seven of ballast is used, and found amply sufficient.

ARCHITECTURE AND ART IN MANCHESTER.

After a long period of depression, art in Manchester has sprung into vigorous existence. The tide of prosperity in trade has influenced architecture, and the town is now a striking example of prevailing good taste. An increased want of buildings of every description, churches, houses, warehouses, manufactories, and public buildings; the formation of several new and large streets, and the widening of old ones, have created a demand for the services of architects, such as we do not recollect any other instance of. A new school of architects has sprung up, including a large number of individuals, many of them very young men; and it is greatly to the credit of the merchants of the town, that they have had the judgment to use the services of architects, in buildings, in which they are seldom appealed to, and to the credit of the architects, that these appeals

* It was usually thus compounded by the late John Nash, Esq.

† Vitruvius says the Romans used three parts of sand to one of lime; but Pliny says four to one. There is little doubt but that their opinions were as various as are ours. Dr. Higgins recommends one of lime *by weight* to eight of sand, in his "Treatise on Calcareous Cements," p. 780.

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